CHEM 101 Exam ~~2~~ 3

Student: _____

I Multiple Choice (33 points) 3 each

1. An exothermic reaction causes the surroundings to:
(A) warm up
B. become acidic
C. expand
D. decrease in temperature
E. release CO_2

2. When heat is absorbed by the system and work is done by the system on the surroundings then
A. q is negative and w is positive.
B. both q and w are positive.
C. both q and w are negative.
(D) q is positive and w is negative.
E. q is positive for endothermic processes and w is positive for endothermic processes.

3. Select the correct electron configuration for sulfur ($Z = 16$).
A. $1s^2 1p^6 2s^2 2p^6$
B. $1s^2 2s^2 2p^8 3s^2 3p^4$
C. $1s^2 2s^2 2p^8 3s^2 3p^2$
(D) $1s^2 2s^2 2p^6 3s^2 3p^4$
E. $1s^2 2s^2 2p^6 3s^2 3d^4$

4. Which two of the four electron configurations below represent elements that would have similar chemical properties?
(1) $1s^2 2s^2 2p^4$
(2) $1s^2 2s^2 2p^5$
(3) $[Ar] 4s^2 3d^{10} 4p^3$
(4) $[Ar] 4s^2 3d^{10} 4p^4$

A. (1) and (2)
B. (1) and (3)
(C) (1) and (4)
D. (2) and (4)
E. (2) and (3)

5. Which of these elements exhibits chemical behavior similar to that of potassium?
A. magnesium
(B) sodium
C. sulfur
D. chlorine
E. iron

Student: 3 each

6. Which of these atoms has the smallest radius?
A. Al
B. P
C. As
D. K
E. Na

7. Which one of these ions has the largest radius?
A. Cl^-
B. K^+
C. S^{2-}
D. Na^+
E. O^{2-}

8. The shape of an atomic orbital is associated with
A. the principal quantum number (n).
B. the angular momentum quantum number (l).
C. the magnetic quantum number (m_l).
D. the spin quantum number (m_s).
E. the magnetic and spin quantum numbers, together.

9. Which of the following is a correct set of quantum numbers for an electron in a 3d orbital?
A. $n = 3, l = 0, m_l = -1$
B. $n = 3, l = 1, m_l = +3$
C. $n = 3, l = 2, m_l = 3$
D. $n = 3, l = 3, m_l = +2$
E. $n = 3, l = 2, m_l = -2$

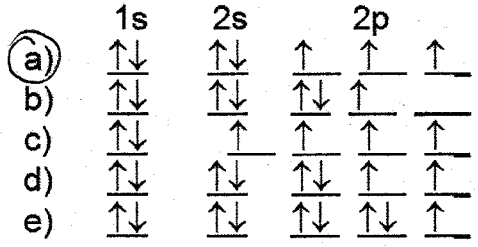
10. Which one of the following sets of quantum numbers is not possible?

	n	l	m_l	m_s
a	4	3	−2	+1/2
b	3	0	1	−1/2
c	3	0	0	+1/2
d	2	1	1	−1/2
e	2	0	0	+1/2

A. a
B. b
C. c
D. d
E. e

Student: _____

11. The orbital diagram for a ground-state nitrogen atom is 3 pts



A. a
B. b
C. c
D. d
E. e

II. Short Answer (22 points)

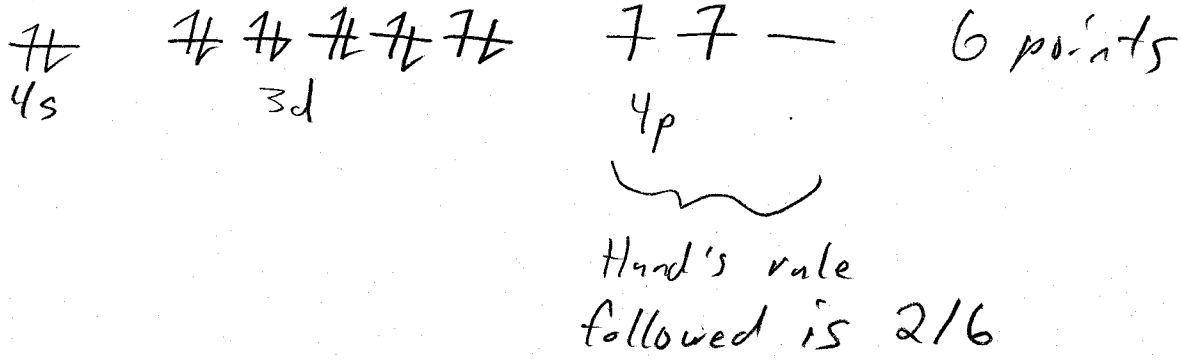
12. (3 points) alkali metals is the name of the elements in Group IA.

13. (3 points) electron affinity is the energy released when a single atom in the gas phase accepts an electron. "EA" = (1)

14. (4 points) What is the total number of electrons that can occupy the 4*d* orbitals? 10

15. (12 points) Write the ground state electron configuration for the germanium atom (Ge). (Look at question 3 for examples of electron configurations, if this term is not clear to you.) Also draw an orbital diagram, using arrows to indicate electrons and their spin, and labeling the orbitals. (Look at Question 11 for examples of orbital diagrams, if this is unclear to you.) For this question, you may use the square-bracket abbreviations such as [He].

[Ar] $4s^2$ $3d^{10}$ $4p^2$ 6 points



6 points

Student: Key

III. Calculations (40 points). SHOW WORK FOR CREDIT

16. (10 points) Given the following $\Delta H°$ values,
$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$ $\Delta H° = -285.8$ kJ/mol
$H_2(g) + O_2(g) \rightarrow H_2O_2(l)$ $\Delta H° = -187.6$ kJ/mol,

calculate $\Delta H°_{rxn}$ for the reaction $H_2O_2(l) \rightarrow H_2O(l) + \frac{1}{2}O_2(g)$ -98.2

$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$ $\Delta H° = -285.8$ kJ/mol

$H_2O_2(l) \rightarrow H_2(g) + O_2(g)$ $\Delta H° = +187.6$ kJ/mol

$H_2O_2(l) \rightarrow H_2O(l) + \frac{1}{2}O_2(g)$ $\Delta H° = -98.2$ kJ/mol

~ add formulas ✓ 4
right signs 3
right answer 3

(wrong s.f. $-\frac{1}{2}$)

17.(10 points) A 0.1375-g sample of solid magnesium is burned in a constant-volume bomb calorimeter that has a heat capacity of 3024 J/°C. The temperature increases by 1.126 °C. Calculate the heat given off by the burning Mg in kJ/mol.

$q = C\Delta T$ (or similar)
$= (3024\ J/°C)(1.126°C)$ } 3
$= 3405\ J$
$= 3.405\ kJ$ } 1

$Q = mC\Delta T$ } 2
$Q = 468.2\ J$ ✓

Something like: $\frac{3.405\ kJ}{0.1375\ g} \times \frac{24.3050\ g}{mol} = 601.9\ kJ/mol$ } 6

(wrong sf $-\frac{1}{2}$)

ignore sign

e.g. 3. if $\frac{kJ}{g}$ part OK

3. if g→mol part OK

Student: _____

18. (10 points) The enthalpy of combustion of acetylene C_2H_2 is described by
$C_2H_2(g) + (5/2)O_2(g) \rightarrow 2CO_2(g) + H_2O(l)$
Calculate the $\Delta H°_{rxn}$, given the following enthalpies of formation: $\Delta H°_f[CO_2(g)] = -393.5$ kJ/mol, $\Delta H°_f[H_2O(l)] = -285.8$ kJ/mol, and $\Delta H°_f[C_2H_2(g)] = +226.6$ kJ/mol.

$\Delta H°_{rxn} = \sum \Delta H_f$ (products) $- \sum \Delta H_f$ (reactants) Setup 3

$= -\{[2\times(-393.5) + (-285.8)] - [226.6]\}$ kJ/mol (calc. 6 -1 for each wrong sign or coeff.)

$= -1299$ kJ/mol (sigfigs/units 1 (ignore sf.)

19. (10 points) Calculate the wavelength (in nm) of the photon emitted when an electron in a hydrogen atom falls from the n=4 state to the n=2 state.

$\Delta E = -2.18\times10^{-18}\text{J}\left(\frac{1}{4} - \frac{1}{16}\right)$ ← $\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$ } 3

$= -4.09\times10^{-19}$ J

∴ E of photon $= 4.09\times10^{-19}$ J $= h\upsilon$ } 3

$\upsilon = \frac{4.09\times10^{-19}\text{J}}{6.63\times10^{-34}\text{ J·s}} = 6.17\times10^{14}$ Hz (or s^{-1})

$\lambda = \frac{c}{\upsilon} = \frac{3.00\times10^{8}\text{ m/s}}{6.17\times10^{14}\text{ s}^{-1}} = 4.87\times10^{-7}$ m } 3

(some may use $\frac{1}{\lambda} = \frac{2.18\times10^{-18}\text{J}}{hc}\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$; that's OK too!)

$\times \frac{1\text{ nm}}{10^{-9}\text{ m}}$ or similar } 1

$= 487$ nm

ignore SF, sign